The repetition effect: A methodological consideration

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The appropriateness of averaging the reaction times (RT) for stimulus events with different probabilities of occurrence in determining the magnitude of the "repetition effect" was examined. Each of five Ss performed under two experimental conditions: (1) a two-choice condition in which the stimulus events were equiprobable and (2) a two-choice condition in which one of the stimulus events appeared with the probability of .70. A detailed analysis of the data clearly demonstrated how the commonly used averaging process can lead to misleading interpretations regarding the nature of the repetition effect.

Most of the research on sequential effects in reaction-time (RT) data centers around the phenomenon known as the "repetition effect," i.e., the often reported finding that the RT to a repeated signal is faster than the RT for a changed signal. In determining the repetition effect for data collected from a choice-reaction time (CRT) task, it has become common practice to merely find the difference between the mean for repetitions and nonrepetitions. Nonrepetition (i.e., stimulus events immediately preceded by a different stimulus) are not subdivided into additional categories on the basis of the characteristics of the particular pair of adjacent stimulus events involved, such as their relative probabilities. For examples of the use of this procedure, the reader is referred to the studies reported by Falmagne (1965) and Leonard, Newman, & Carpenter (1966). Although the procedure of collapsing or combining certain components of RT data simplifies calculation of the repetition effect, the meaningfulness of the resulting measure is open to question. The present paper examines the appropriateness of averaging the RTs for stimulus events with different probabilities of occurrence in determining the magnitude of the repetition effect.

SUBJECTS

Five volunteer Ss (three females and two males) participated in the experiment. The Ss ranged in age from 15 to 28 years.

APPARATUS

The signals were presented by means of a visual display consisting of two lights approximately 1 in. in diam. The response device was a small keyboard. The depression of a key following a stimulus light was followed by the automatic recording of the RT with millisecond accuracy, stimulus identification, and the specific key(s) depressed by S. A fixed 1-sec delay between the onset of a warning light and the onset of the stimulus light was employed throughout the experiment

STIMULUS SEQUENCES

All of the stimulus sequences employed in the present experiment were 200 trials long. Randomization of the stimulus events was achieved by means of a computer program. Additional structural characteristics of these stimulus sequences are presented in the following description of the experimental conditions:

50:50 condition. Four different binary sequences were constructed for this experimental condition. Under the 50:50 condition, both stimulus alternatives, consisting of Light 1 and Light 2 were presented equally often in each of the four 200-trial stimulus sequences.

70:30 condition. The second condition also employed a binary-choice reaction task. For this condition, four different stimulus sequences were constructed so that the proportions of alternatives were 70:30. Second- and third-order estimates of redundancy for the combined stimulus sequences were nearly zero for both two-choice conditions.

PROCEDURE

Each S performed under both experimental conditions. During a typical experimental session, S was presented with four 200-trial stimulus sequences. Before each sequence, S was told the probability associated with the appearance of each of the possible stimulus events in terms of percentages. The Ss were instructed to respond as quickly as possible to the presentation of the stimulus light without making more than 5% error responses during a given series.

GENERAL DATA ANALYSIS

A relatively stable pattern of higher-order sequential effects was observed for the last four blocks for the 50:50 condition. The first two blocks for this condition, being the first two blocks of practice on a CRT task for all Ss, were characterized by rather erratic higher-order sequential effects as well as a large drop in overall mean RT. Therefore, the first two

blocks (i.e., the first 400 CRTs for each S under the condition) were excluded from the final data analysis for this experimental condition. Only the first block of trials for the 70:30 condition displayed an unstable pattern of higher-order sequential effects. With the first block excluded from analysis, 5,000 RTs from the last five blocks remained to be analyzed. Therefore, the analyzable RT data consisted of 800 data records for each of five Ss under the 50:50 condition and 1,000 data records from each S under the 70:30 condition. A more detailed account of experimental procedure and data analysis can be found in Remington (1969).

RESULTS AND DISCUSSION

Following the procedure introduced by Bertelson (1961), RT was plotted as a function of rank in a run of repetitions (0 = alternation; +1 = 1st repetition; +2 = 2nd repetition; etc.). The resulting plots for all Ss combined under both conditions are shown in Fig. 1. Except for the initial drop associated with the difference between the 0 position and 1 position (i.e., the repetition effect), the trends for the two conditions are very similar. It appears that the 70:30 condition produced a greater repetition effect than the 50:50 condition. However, when a similar analysis is made on the individual components of the 70:30 condition, it becomes clear that the greater repetition effect associated with this condition is an artifact produced by the somewhat common practice of averaging over the components that make up an experimental condition. Figure 2 shows the mean RTs for position in run for each component in the 70:30 condition separately as well as those for the

Fig. 1. Reaction time as a function of position in a run of repetitions for the 50:50 condition and the 70:30 condition.

Fig. 2. Reaction time as a function of position in a run of repetitions for each component and overall average for the 70:30 condition.

components combined. It now becomes apparent that the large repetition effect for the 70:30 condition is merely due to the fact that while both components contribute equally to the average for an alternation (Position 0), the 70% component, with its greater number of repetitions and faster RTs, largely determines the overall mean RT for the initial repetitions. The sharp drop in the overall mean RT in the 70:30 condition is a reflection of this averaging process rather than the magnitude of the repetition effect. Failure to recognize this fact would also lead one to overestimate the relative importance of the first repetition (i.e., the repetition effect) and underestimate the role of additional repetitions. For an example of how the process of averaging over the components of an experimental condition has produced this sort of misleading interpretation in previous research, the reader is advised to see the study reported by Leonard et al (1966). These authors present a graph (Fig. 3, p. 137) that is very similar to Fig. 1 in the present paper. Averaging over a five-component experimental condition (i.e., a condition involving five stimulus signals, one of which appeared 68% of the time) produced what was interpreted by these authors as being a "strong repetition effect."

Most of the current models of sequential effects in CRT are based on the theoretical notion that the time required to process a given signal is relatively independent of the signals presented more than one trial back (e.g., the model presented by Bertelson, 1963). The repetition function for the 70:30 condition in Fig. 1 obtained by the usual averaging process would tend to support this notion. However, the more

detailed analysis presented in Fig. 2 clearly demonstrates how the averaging process can lead to a misleading interpretation. The repetition function for the 30% component is practically linear through four repetitions. The small number of observations for repetitions beyond four for the 30% component makes it impossible to assess reliably the nature of the function beyond this point. Clearly, an adequate model of CRT must account for third, fourth, and possibly higher-order sequential effects.

In determining the repetition effect for data collected from a CRT task involving more than two choices, the RTs for stimulus events immediately preceded by a different stimulus are customarily pooled to arrive at a single value for nonrepetitions (e.g., Falmagne, 1965; and Hale, 1969). The findings from the present study tend to indicate that the appropriateness of such averaging should be determined by a detailed sequential analysis of each nonrepetition component. Differential

effects among the nonrepetition components could lead to misleading interpretations regarding the nature of the repetition effect similar to those found in the present study.

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The influence of semantic and acoustic similarity on retention of short sentences

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Short sentences were used as the learning material in retroactive-interference (RI) and proactive-interference (PI) designs. The relative influence of acoustically and semantically similar interfering sentences in the two designs was studied. Significant PI but no significant RI effect was found. Both acoustically and semantically similar material interfered with retention, with the latter having a more powerful influence.

Adams (1967, pp. 116-120) has summarized some of the evidence for a possible distinction between long-term memory (LTM) and short-term memory (STM). He and others (e.g., Baddeley, 1966; Baddeley & Dale, 1966) hold that interference effects in STM are based on the dimension of acoustic similarity while interference effects in LTM relate to semantic similarity. Connected discourse would seem to fall in the category of learning material that belongs in or is rapidly transferable to LTM rather than STM. In any case, none of the studies comparing acoustic and semantic similarity effects have used connected discourse as the learning material. Although Slamecka (1960) has demonstrated significant retroactive interference (RI) as a function

of similarity of topic in connected discourse, his method of presentation was not one that approximated natural speech. A more natural method of presentation was followed in the present study with standard RI and proactive interference (PI) designs used to determine the relative influence of acoustically and semantically similar interfering sentences on retention.

SUBJECTS AND MATERIALS

Twelve classes of introductory psychology students at Oswego served as Ss in this experiment. Ss were randomly eliminated to balance all 12 treatment conditions at 25 Ss each. Treatment conditions were randomly determined for the 12 classes.

The learning material consisted of two sets (A and B) of 10-word sentences. Each